REMARKS

On the basis of the foregoing amendments and the Applicants' discussion provided in the response filed December 11, 2002, the present reissue application is believed to be in condition for allowance, which action is respectfully requested. Should the Examiner have any questions, he is invited to telephone the undersigned at the number provided.

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Respectfully submitted,

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APPENDIX A

1. (Twice Amended) A method for forming and solidifying uniform sized and shaped solid spheres comprising the steps of:

providing a supply of a low viscosity liquid material in a crucible,

applying a minute periodic disturbance to the low viscosity liquid material in the crucible,

applying a pressure to the low viscosity liquid material, the pressure forcing the material through at least one orifice in the crucible as a steady laminar stream, the stream of the material exiting into an enclosed controlled low temperature solidification environment having a temperature of less than about 0° C., the enclosed controlled low temperature solidification environment containing at least a first heat transfer medium and a second heat transfer medium, the first heat transfer medium and the second heat transfer medium forming a heat gradient within the enclosed controlled low temperature solidification environment;

breaking the stream of material up into a plurality of uniform sized and shaped liquid spheres, and

allowing the liquid spheres to pass through the first heat transfer medium and the second heat transfer medium in the enclosed controlled low temperature solidification environment to cool and solidify into the uniform sized and shaped solid spheres.

2. (Amended) The method of claim 1, in which the enclosed controlled temperature solidification environment includes a first or gaseous environment through which the spheres are passed, the first or gaseous environment containing the first heat transfer medium which comprises a spray of cooling fluid, liquefied gas or halo-carbon which evaporates in the enclosed controlled temperature solidification environment and which absorbs the heat of fusion from the spheres.

3. (Amended) The method of claim 2, in which the enclosed controlled temperature solidification environment includes a second or liquid environment through which the spheres pass after passing through the first or gaseous environment, the second or liquid environment containing the second heat transfer medium which comprises a supply of a liquid material.

4. (Amended) The method of claim 3, comprising passing the spheres through the second or liquid environment to remove heat from the spheres and to cushion the spheres before the spheres contact a bottom of the enclosed controlled temperature solidification environment.

5. The method of claim 3, comprising varying a distance defined between a point at which the stream breaks into the spheres and a point at which the spheres contact the second or liquid environment.

6. The method of claim 1, further including the step of visually monitoring the stream of low viscosity liquid material as the stream breaks into spheres to provide information on the diameter and shape of the spheres and the stability of the stream.

7. The method of claim 1, comprising collecting the solidified spheres in a funnel-shaped bottom of the enclosed controlled temperature solidification environment.

8. The method of claim 1, in which the solid spheres have a diameter ranging from about 12 to about 1000 microns.

9. The method of claim 1, in which the spheres pass through the enclosed controlled temperature solidification environment for about 0.5 to about 1.5 seconds prior to contacting a bottom of the enclosed controlled temperature solidification environment.

10. The method of claim 1, comprising applying the minute, periodic disturbance to the low viscosity liquid material by a piezoelectric actuator.

11. The method of claim 10, in which the piezoelectric actuator comprises a stack of piezoelectric crystals mounted on a top portion of the crucible.

12. The method of claim 1, comprising applying the minute periodic disturbance to the low viscosity liquid material by an electromechanical transducer mounted on a top portion of the crucible.

13. The method of claim 1, comprising applying the minute periodic disturbance with a nozzle that has a fixed aspect ratio defining the orifice.

14. The method of claim 1, comprising applying a substantially constant positive pressure to the low viscosity liquid material to force the low viscosity liquid material out through the orifice in a steady laminar stream.

15. (Twice Amended) The method of claim 29, in which the deflection means comprises two spatially separated surfaces and comprising generating the electric field between the two surfaces to deflect the liquid spheres.

16. (Twice Amended) A method for forming uniform sized and shaped spheres comprising the stops of:

providing a supply of a low viscosity liquid material in a crucible,

applying a minute periodic disturbance to the low viscosity liquid material in the crucible,

applying a pressure to the low viscosity liquid material, the pressure forcing the material through at least one orifice in the crucible as a steady laminar stream, the stream of the material exiting into an enclosed controlled temperature solidification environment;

breaking the stream of material up into a plurality of uniform sized and shaped liquid spheres; and

allowing the spheres to pass through first and second media in an enclosed controlled temperature solidification environment to cool and solidify the spheres;

the enclosed controlled temperature solidification environment including a first or gaseous environment through which the charged spheres are passed, the first or gaseous environment containing the first medium which comprises a spray of cooling fluid, liquefied gas or halo-carbon, the first medium evaporating in the enclosed controlled temperature solidification environment and absorbing the heat of fusion from the spheres;

the enclosed controlled temperature solidification environment also including a second or liquid environment through which the spheres pass after passing through the first, gaseous environment, the second or liquid environment containing the second medium which comprises a supply of a liquid material, the second medium cushioning the spheres before the spheres contact a bottom of the enclosed controlled temperature solidification environment.

17. The method of claim 16, further including the step of visually monitoring the stream of low viscosity liquid material as the stream breaks into spheres to provide information on the diameter and shape of the spheres and the stability of the stream.

18. The method of claim 16, comprising collecting the solidified spheres in a funnel-shaped bottom of the enclosed controlled temperature solidification environment.

19. The method of claim 16, in which the spheres have a diameter ranging from about 12 to about 1000 microns.

20. The method of claim 16, in which the spheres pass through the enclosed controlled temperature solidification environment for about 0.5 to about 1.5 seconds prior to contacting a bottom of the enclosed controlled temperature solidification environment.

21. The method of claim 16, in which the enclosed low temperature solidification environment is at a temperature of less than about 0° C.

22. The method of claim 16, comprising varying a distance defined between a point at which the stream breaks into the spheres and a point at which the spheres contact the second, liquid environment.

23. The method of claim 16, comprising applying the minute periodic disturbance to the low viscosity liquid material by a piezoelectric actuator.

24. The method of claim 23, in which the piezoelectric actuator comprises a stack of piezoelectric crystals mounted on a top portion of the crucible.

25. The method of claim 16, comprising applying the minute periodic disturbance to the low viscosity liquid material by an electromechanical transducer mounted on a top portion of the crucible.

26. The method of claim 16, comprising applying the minute periodic disturbance with a nozzle that has a fixed aspect ratio defining the orifice.

27. The method of claim 16, comprising applying a substantially constant positive pressure to the low viscosity liquid material to force the low viscosity liquid material out through the orifice in a steady laminar stream.

28. The method of claim 16, in which the deflection means comprises two spatially separated surfaces and comprising generating the electrical field between the two surfaces to deflect the descending spheres.

29. (New) The method of claim 1, further comprising steps of:
applying a charge to the stream of material as the stream exits the orifice; and
passing liquid spheres to which the charge has been applied through an electric field to deflect the charged liquid spheres.

30. (New) The method of claim 16, further comprising steps of:
applying a charge to the stream of material as the stream exits the orifice; and
passing liquid spheres to which the charge has been applied through an electric field to deflect the charged liquid spheres.

31. (New) A method for forming and solidifying uniform sized and shaped solid spheres comprising the steps of:

applying a pressure to low viscosity liquid material contained in a crucible, the pressure forcing the material through at least one orifice in the crucible as a steady laminar stream, the stream of the material exiting into an enclosed controlled low temperature solidification environment having a temperature of less than about 0° C., the enclosed controlled low temperature solidification environment containing at least a first heat transfer medium and a second heat transfer medium, the first heat transfer medium and the second heat transfer medium forming a heat gradient within the enclosed controlled low temperature solidification environment; and

allowing the liquid material to pass through the first heat transfer medium and the second heat transfer medium in the enclosed controlled low temperature solidification environment to cool and solidify into the uniform sized and shaped solid spheres.

32. (New) A method for forming and solidifying uniform sized and shaped solid spheres, the method comprising:

providing a supply of a low viscosity liquid material in a crucible,

applying a minute periodic disturbance to the low viscosity liquid material in the crucible,

applying a pressure to the low viscosity liquid material, the pressure forcing the material through at least one orifice in the crucible as a steady laminar stream, the stream of the material exiting into an enclosed controlled low temperature solidification environment having a temperature of less than about 0° C., the enclosed controlled low temperature solidification environment containing at least one heat transfer medium forming a heat gradient within the enclosed controlled low temperature solidification environment;

breaking the stream of material up into a plurality of uniform sized and shaped liquid spheres, and

allowing the liquid spheres to pass through the heat transfer medium in the enclosed controlled low temperature solidification environment to cool and solidify into the uniform sized and shaped solid spheres.

33. (New) The method of claim 32 wherein forming the heat gradient includes the enclosed controlled temperature solidification environment including a first or gaseous environment containing the first heat transfer medium at a temperature of a first desired value through which the liquid spheres pass.

34. (New) The method of claim 33 wherein the first heat transfer medium includes a spray of cooling fluid, liquefied gas or halo-carbon which evaporates in the enclosed controlled temperature solidification environment and which absorbs the heat of fusion from the liquid spheres.

35. (New) The method of claim 33 wherein forming the heat gradient further includes the enclosed controlled temperature solidification environment including a second or liquid environment containing a second heat transfer medium at a temperature of a second desired value through which the liquid spheres pass after passing through the first or gaseous environment.

36. (New) The method of claim 35 wherein the second heat transfer medium includes a supply of liquid material which removes heat from the spheres and which cushions the spheres before the spheres contact a bottom of the enclosed controlled temperature environment.

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